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EVALUATION OF THE 2003 MODEL CODES FINAL REPORT

BACKGROUND

OSHPD Authority

The Office of Statewide Health Planning and Development (OSHPD) is the adopting and enforcing agency for the California Building Standards Code, Title 24, California Code of Regulations (CCR), with application to Hospitals, Skilled Nursing Facilities, Correctional Treatment Facilities, and Licensed Clinics. OSHPD has the authority to amend the adopted model building code as necessary to achieve the performance objectives defined in the Alfred E. Alquist Hospital Facilities Seismic Safety Act. The act reads in part:

> It is the intent of the Legislature that hospital buildings that house patients who have less than the capacity of normally healthy persons to protect themselves, and that must be reasonably capable of providing services to the public after a disaster, shall be designed and constructed to resist, insofar as practical, the forces generated by earthquakes, gravity, and winds. In order to accomplish this purpose, the office shall propose proper building standards for earthquake resistance based upon current knowledge, and provide an independent review of the design and construction of hospital buildings. (§129680(a)).

OSHPD also promulgates administrative code provisions within Part 1, Title 24, CCR pertaining to enforcement of building standards.

California Building Standards Law (Health and Safety Code §18929.1) requires that OSHPD and other state agencies meet specific criteria when proposing the adoption, amendment, or repeal of provisions in the California Building Standards Code. This requirement includes consideration of the "Nine-Point Criteria." Included in these criteria are restrictions on adoption of building standards that are in any way ambiguous or vague, in whole or in part. In addition, increase in cost to the public must be reasonably based on overall benefit to be derived from the building standards. In arriving at our selection of a model building code, OSHPD has accorded special consideration to these two criteria.

Overview

The purpose of the building code is to provide for public safety, through an efficient and consistent set of rules for construction. The building code is not a design manual or a construction guide. Vague or contradictory language, rather than providing flexibility, in fact causes confusion and delays, as designers, contractors and building officials struggle to determine the meaning and intent of the code. In adopting a model code,

the enforcing agency reviews and coordinates the code, amending it as necessary to meet its statutory requirements and eliminate conflicts and ambiguities.

OSHPD has evaluated the 2003 *NFPA 5000 Building Construction and Safety Code (NFPA 5000)*, published by the National Fire Protection Association (NFPA), and the 2003 *International Building Code (IBC),* published by the International Code Council (ICC), for adoption as the base document for 2004 *California Building Code (CBC)*. As part of the evaluation, OSHPD considered the structural and non-structural aspects of design and construction, as well as architectural and fire & life-safety provisions that affect structures regulated by OSHPD.

OSHPD has used a three-phase approach to our evaluation.

1. We have reviewed the level of safety provided by the model codes:
   - Compared to the current level of safety provided by the 2001 *CBC*, and
   - Compared to each other.

2. We have evaluated the amount of work needed to amend the codes as required for the design and review of health care facilities, considering:
   - The amendments needed to maintain the current level of safety,
   - The ease with which necessary amendments can be made, both through the model code development process and through California amendments,
   - The use of referenced standards and publications, and the methods for resolving conflicts between referenced standards and the code, and the methods for resolving conflicts between different referenced standards and publications,
   - The amount of work required to review and update Policy Intent Notices (PINs), Code Application Notices (CANs) and other documents.

3. We have evaluated the ease of use of the two model codes from both a design perspective and from a plan review/construction inspection point of view, including:
   - Consideration of the effort that will be required by OSHPD staff and local building officials to understand and enforce the code (local building departments are responsible for enforcement of licensed clinic regulations that OSHPD promulgates). This includes training needed to become proficient in the use of the code, in order to assure correct interpretation and to minimize the impact on plan review turnaround times,
   - Review of the types of support programs offered by ICC and NFPA,
   - Review the clarity and ease of use of the code for architects, engineers and other professionals involved in health care facility construction.

Evaluation Process

To perform our evaluation, OSHPD staff has:

- Performed a comprehensive comparative review of the model codes and the 2001 *CBC*. One aspect of this review where we placed special emphasis is the

structural chapters. In order to perform as detailed a review as possible within our current budget and staffing constraints, and taking advantage of the fact that the structural provisions of the *CBC* adopted by OSHPD and the Division of the State Architect (DSA) are nearly identical, our detailed review of the structural chapters was performed in cooperation with the DSA. A summary of the findings of our comparative review of the structural chapters may be found in Attachment D.

- Participated in the State Fire Marshal's "Operation Code Comparison," and utilized this comparison in our evaluation of the fire and life safety provisions of the proposed model codes affecting buildings under our jurisdiction.
- Attended training presented by NFPA and the International Code Council (ICC).
- Reviewed code evaluation criteria suggested by interested parties.
- Attended public meetings held under the auspices of the California Building Standards Commission, State Fire Marshal and Division of the State Architect to hear testimony of interested parties.
- Requested clarification on different aspects of the model codes from both NFPA and ICC. The questions posed to the model code organizations and their responses are found in Attachment A (NFPA) and Attachment B (ICC).
- Reviewed code comparisons, summaries, and recommendations presented by individuals and professional organizations.
- Prepared this Final Report, detailing our findings and conclusions.

A copy of the presentation made before the California Building Standards Commission on July 16, 2003, is included in Attachment C.

OSHPD Review Team

OSHPD technical staff participated in the review of the model code documents through various state and local organizations, including the NFPA, ICC, ICBO, American Society of Civil Engineers (ASCE), Building Seismic Safety Council (BSSC), National Earthquake Hazard Reduction Program (NEHRP), the Structural Engineers Association of California (SEAOC) and the California State Fire Marshal. A listing of OSHPD staff who participated in the review, and their relevant affiliations are summarized below:

- Susan Botelho – Staff Services Manager III
  - Chief, Regulations Development Section
  - Past President, California Capitol Chapter, ICBO
- Byron "BJ" Foster – Fire/Life Safety Officer
  - Member, NFPA 5000 Height and Area Committee
- Tom Hale – Senior Structural Engineer
  - Co-chair of the SEAOC Central Seismology Committee
  - Past-chair of the State SEAOC Seismology Committee
  - Member of the BSSC/NEHRP 2003 Provisions Technical Subcommittees TS-3 Foundations and Geotechnical Considerations, and TS-12 Base Isolation and Energy Dissipation

- Don Harris – Senior Architect
    - Member, NFPA 5000 Committee on Health Care Occupancies
    - Member, Code 2000 Partnership Egress Working Group
    - Member, OSFM Code Comparison Committee
- John Gillengerten – Senior Structural Engineer
    - Member, Provisions Update Committee (PUC), BSSC/NEHRP Provisions 1994-present
    - Chairman of the BSSC/NEHRP Provisions Technical Subcommittee TS-8, Nonstructural Components and Systems, 1997-present
    - Member, ASCE 7 Task Committee on Earthquake Loads, 1998-present
    - Member, BSSC Code Resource Structural Committee (CRSC), 1997-present
    - Member, NFPA 5000 Committee on Structures and Construction
- Bill Staehlin – Supervising Structural Engineer
    - Current President, SEAOC
    - Past President, Structural Engineers Association of Central California (SEAOCC)
    - Member, ASCE 7 Task Committee on Earthquake Loads, 1998-present
    - ASHRAE member and Past Chair of ASHRAE TC2.7 Seismic Restraint Design
    - Member of the BSSC/NEHRP Provisions Technical Subcommittee TS-8, Nonstructural Components and Systems, 1998-present
- Chris Tokas – SB 1953 Program Manager
    - Past President, SEAOCC
    - Member, ASCE 7 Task Committee on Earthquake Loads
    - Past Chair, SEAOCC Seismology Committee
    - Chair, SEAOC Seismology Committee, 2001 to present
    - Member, International Building Code Structural Committee, 1998 - 2002

Limitations of Evaluation

The task of evaluating two new code sets for adoption is monumental. In order to reduce the task to a manageable size, given the time and staff constraints, the scope of our evaluation was limited, and a number of assumptions were made:

- OSHPD's evaluation is limited to those portions of the Building Code promulgated or enforced by OSHPD. This includes fire and life safety provisions adopted by the State Fire Marshal and enforced by OSHPD.
- Our review was qualitative in nature. Not every potential conflict and problem (or remedy) is covered in this evaluation.
- We performed a cursory review of the Fire Codes. The Building Code provides the minimum standards for building construction. The Fire Code is essentially a maintenance code, used after construction is complete to regulate the use and occupancy of the building. We strongly suggest that the Building and Fire codes that are adopted by California should be from the same "family," since coordination of these two documents is critical.

- We performed a review of the mechanical and plumbing codes. OSHPD proposes that the *Uniform Mechanical Code* and *Uniform Plumbing Code* published by the International Association of Plumbing and Mechanical Officials (IAPMO) should remain the codes adopted by California.
- We did not specifically review the electrical code. The *National Electrical Code* published by NFPA should remain the electrical code adopted by California.

EVALUATION

ARCHITECTURAL AND FIRE AND LIFE SAFETY PROVISIONS

In examining the level of safety provided by the proposed model codes compared to the current *CBC*, both the *IBC* and *NFPA 5000* offer substantially reduced levels of protection than are currently enjoyed under the *CBC*. This reduction is primarily due to tradeoffs in the *IBC* and *NFPA 5000* for fire sprinklers, and increased allowable heights and areas in these codes.

Another major reduction in the level of protection for hospitals and skilled nursing facilities in both the *IBC* and *NFPA 5000,* compared to the CBC, is the allowance of non-fire-rated corridors in hospitals and skilled nursing facilities protected with fire sprinklers. However, *NFPA 5000* goes even farther in Section 19.3.6.1(1), allowing spaces of unlimited area to be open to the corridor, provided they are not used for patient sleeping rooms, treatment rooms or hazardous areas. This would allow hospitals with virtually no walls, except for a few specific types of rooms and smoke barrier walls.

Another significant difference that will affect buildings under OSHPD's jurisdiction is that *NFPA 5000* treats ambulatory healthcare occupancies (clinics) as business occupancies with regard to height and area. This allows surgical clinics in buildings that are much larger and taller than the current *CBC* allows, and even larger than the *IBC* would allow.

OSHPD staff participated in "Operation Code Comparison," the detailed fire and life safety review and analysis of the codes organized by the State Fire Marshal. Our review of the model codes was supplemented with portions of this document that pertain to buildings under OSHPD's jurisdiction. It appears from the data provided in "Operation Code Comparison" that in most areas, both *IBC* and *NFPA 5000* offer lower levels of protection than are currently enjoyed with the *CBC*. Also, the *IBC* and *NFPA 5000* provide roughly equivalent levels of fire and life safety in most areas, compared to each other. In the majority of areas where the two codes differ, a higher level of protection is provided by the *IBC*.

A Blended Family of Codes

While there has been considerable discussion regarding adopting a single "family of codes," this concept may have limited practical value. OSHPD has proposed the adoption of the International Building Code IBC) and International Fire Code (IFC). We

have also proposed adopting NFPA 70, the National Electrical Code (NEC), and the Uniform Plumbing Code (UPC) and Uniform Mechanical Code (UMC), published by IAPMO and part of NFPA's C3 code set. The state has always used the NEC, UPC and UMC, and the coordination issues between these and the building code are relatively few and minor. There are much greater coordination issues when Building and Fire codes from different organizations are chosen. OSHPD has not have reviewed the International Residential Code (IRC), since it does not affect buildings under our jurisdiction.

Building and Fire Codes

Some individuals have suggested that it might be possible to use the building code from one code organization and the fire code from the other. The building and fire codes are clearly the two codes that must be from a single code set. The Building Code contains regulations for how to construct a building, and the Fire Code provides regulations for how to maintain the building once construction is complete. They are designed and written to work together as a unit. Both fire codes extract large portions of text directly from the corresponding building code. (In the case of *NFPA 1/UFC*, much of the text is actually extracted from *NFPA 101 Life Safety Code*, which forms the basis of much of *NFPA 5000*.)

The Building and Fire Codes from the same organization share a common philosophy and organizational structure. Definitions and technical requirements are standardized. Occupancy classifications, types of construction, means of egress, fire protection and suppression systems, and many other elements are all coordinated. None of these is true when building and fire codes from different organizations are mixed, and neither code can function as it was intended, if it can function at all. The task of amending the codes so that they can function together is nearly insurmountable at the state level, and the codes would remain completely dysfunctional and unusable by local jurisdictions.

It has been pointed out that the work of the Code 2000 Partnership was stopped because the task of identifying and resolving the conflicts between the Building and Fire codes was too great a task to complete in the time available. The codes under consideration at that time were the *International Building Code* and the *Uniform Fire Code*. These documents are both part of, or directly descended from, the Uniform code set. They are much more similar in format and content than the *International Building Code* and *NFPA 1/UFC,* so it can be inferred that the difficulties in coordination will be proportionately greater if codes from different organizations are selected.

Mechanical, Plumbing and Electrical Codes

Some have also mistakenly stated that there were too many conflicts between the Building Code and the Mechanical, Plumbing and Electrical Codes to resolve during the Code 2000 Partnership. This is not the case. Conflicts between these codes were easily identifiable, and amendments to resolve these conflicts fairly easy to implement. In fact, the state has adopted and used the Uniform Mechanical Code, Uniform Plumbing Code and National Electrical Code for decades, even though they are

produced and published by different organizations with differing affiliations. There is no reason to believe that there will be any greater difficulty in using these codes as part of the 2004 California Building Standards Code.

NFPA 5000 and the *International Residential Code*

A significant number of buildings under OSHPD jurisdiction are designed using conventional wood frame construction. It has been suggested that adopting the *IRC* with *NFPA 5000* would solve the problems that have been identified with the wood chapters in *NFPA 5000*. However, the *IRC* is very narrowly scoped, and only applies to one- and two-family dwellings and townhouses, not more than three stories in height. Other occupancies, such as skilled nursing facilities, and taller structures cannot be reviewed using the *IRC*, and would therefore fall under the scope of *NFPA 5000*. Our discussion of NFPA's wood chapter demonstrates that this is not a workable solution.

NFPA 1/Uniform Fire Code v. International Fire Code

Most of the requirements in the Fire Codes are dedicated to the maintenance and protection of existing structures. OSHPD has reviewed those portions of the Fire Codes that pertain to building construction. Based on our review, and our evaluation of the State Fire Marshal's "Operation Code Comparison" document, the *IFC* and *NFPA 1/UFC* appear to provide nearly equal levels of protection in most areas, and both are fairly well coordinated with their companion building codes. Some exceptions to this are explained in detail below. The *IFC* contains many sections that are extracted directly from the *IBC*. *NFPA 1/UFC* does not refer to *NFPA 5000*, but rather to many other NFPA documents. Many sections are extracted directly from *NFPA 101 Life Safety Code*. Based on our comparative review of the *IFC* and *NFPA 1/UFC*, we find the *IFC* to be better coordinated, and references to the corresponding Building Code more direct and clear.

Coordination Issues with *NFPA 5000*

NFPA representatives have testified before the Commission and other bodies, and stated in their correspondence that the NFPA documents are "automatically coordinated" with each other. While this assertion may raise questions about the specific aspects of "automatic" coordination, the NFPA codes indicate there are serious flaws in the coordination process.

For example, *NFPA 1/UFC*, Section 12.7.3.1 states, "Wall openings required to have a fire protection rating by the table in 12.7.3.1 shall be protected by approved… assemblies…" No table is located in the referenced section, nor is any table located on that page of the code.

Another example can be found in the requirements for the protection of penetrations in smoke barrier walls and fire barrier walls. Similar requirements are found in three separate NFPA documents: *NFPA* 5000, *NFPA 1/UFC*, and *NFPA 101*. The differences in the text (shown below in boldface type) are subtle, but the effect is quite substantial.

NFPA 5000, Section 8.11.5.3 reads:

> "Where a smoke barrier is also constructed as a fire barrier, the penetrations shall be protected in accordance with the requirements of Section 8.8 to limit the spread of fire for a time period equal to the fire resistance rating of the assembly as required by 8.11.5 to restrict the transfer of smoke."

This section refers to Section 8.8, governing the protection of penetrations in fire walls, fire barrier walls, and fire resistance-rated horizontal assemblies, which appears to be an appropriate reference. The last portion of the sentence, however, makes no sense. It seems to indicate that the time period for fire resistance of the assembly is found in the section to restrict the transfer of smoke. The text of the section obviously does not convey the desired intent, nor is it possible to determine what the intent should be from the text.

NFPA 1/UFC, Section 12.9.6.3 is similar, but the last half of the section has been rewritten:

> "Where a smoke barrier is also constructed as a fire barrier, the penetrations shall be protected in accordance with the requirements of Section **8.4 of *NFPA 101*** to limit the spread of fire for a time period equal to the fire resistance rating of the assembly **and 12.9.6 to resist the transfer of smoke, unless the requirements of 12.9.6.4 are met. [*101*:8.5.5.3]**"

In *NFPA 1/UFC*, the last portion of the section, which deals with the spread of smoke, is clarified, and a very limited exception is added for fire sprinkler piping. However, *NFPA 1/UFC* refers to Section 8.4 of *NFPA 101* for requirements for the spread of fire. This section is titled "Smoke Partitions," and contains no requirements for the spread of fire, since smoke partitions are not required to have a fire resistance rating. This appears to be an incorrect reference.

Since the *Fire Code* refers to *NFPA 101, Life Safety Code*, we checked the corresponding section here as well. The text of *NFPA 101*, Section 8.5.5.3 is nearly identical to the *Fire Code*, but refers to a different section for requirements to limit the spread of fire.

> "Where a smoke barrier is also constructed as a fire barrier, the penetrations shall be protected in accordance with the requirements of **8.3.5** to limit the spread of fire for a time period equal to the fire resistance rating of the assembly and **8.5.5 to resist the transfer of smoke, unless the requirements of 12.9.6.4 are met.**"

This section in *NFPA 101, Life Safety Code* contains what is perhaps the correct version of these requirements. Code references for both the spread of fire and the transfer of smoke are to sections that contain applicable requirements.

A separate but related issue is addressed in this section. *NFPA 1,* Section 12.9.6.4 allows the space around a sprinkler pipe that penetrates a single membrane of a fire rated wall to be protected with a non-combustible escutcheon plate if the space around the pipe does not exceed ½ inch. However, *NFPA 13*, which regulates the installation of fire sprinkler systems, contains no such exception. *NFPA 13*, Section 6-4.4 indicates that the hole through the wall must be at least two inches larger than the pipe, and this space must be filled with flexible material "where required," presumably in fire rated walls. No clearance is needed between sprinkler pipe and gypsum board if the wall is not required to have a fire rating.

A set of codes that are "automatically coordinated" should have requirements and exceptions that are similar from one document to another. This does not appear to be the case with the NFPA documents we reviewed. We did not find any similar lapses in coordination in the IFC.

STRUCTURAL PROVISIONS

General

The 2001 *CBC* encompasses over half a century of incremental improvements in the *Uniform Building Code (UBC)*. The *UBC* and *CBC* provisions have been developed in response to unique regional conditions, including California's high level of seismic activity. In contrast, both the *IBC* and *NFPA 5000* codes represent efforts to develop a single code to be used throughout the nation. As such, they differ significantly from the 2001 *CBC*, in some areas being more conservative, in others less.

The structural provisions of *IBC* and *NFPA 5000* follow a developing trend that began with the 1997 *UBC*. In the 1997 *UBC*, the National Earthquake Hazard Reduction Program *Recommended Provisions for Seismic Regulations for New Buildings* (*NEHRP Provisions*) became the technical basis for the seismic design provisions of the *UBC*, replacing the recommended seismic provisions promulgated by the Structural Engineers Association of California.

The seismic design methodology, upon which both the *IBC* and *NFPA 5000* are based, is dramatically different from that in the 2001 *CBC*. The concept of seismic zones, which divided the state into two levels of risk, has been replaced with contour maps showing expected ground shaking intensity. Since all of California was classified in seismic zones 3 or 4 (the areas of highest risk), building systems like unreinforced masonry (URM), which have historically performed very poorly in earthquakes, were prohibited.

As a result of the new seismic hazard mapping approach used in the *IBC* and *NFPA 5000*, earthquake design lateral force levels now vary dramatically from one part of the state to another. In the 2001 *CBC*, the difference between design force levels between regions of highest and lowest seismic activity in California was a factor of 2. Under either proposed code, the difference will be a factor of 8 to 10. The proposed codes will allow the reintroduction of low ductility structural systems (such as unreinforced

concrete and URM), which have not been permitted in California for 70 years. We believe that this is an unintended consequence of the change in seismic design procedures, reflected by the fact that there are currently code change proposals under consideration for the 2003 edition of the *NEHRP Provisions* that will restrict the use of the low ductility systems in areas of moderate seismicity nationwide, including areas of California. However, even if these proposals are successful at the national level, it will be at least 3 years before the changes are reflected in *ASCE 7-05 Minimum Design Loads for Buildings and Other Structures* (2005 edition), the primary source document for seismic design used by both model codes. In the interim, state and local enforcement agencies will have to amend the code to restrict the use of these low-ductility building systems.

The practice of tying seismic detailing and design requirements to seismic zone has been abandoned. Seismic design requirements are now tied directly to the type of lateral force resisting system in the building. For example, the design and detailing requirements of a steel special moment frame building are the same whether the building is constructed in Los Angeles or Oklahoma City.

The use of certain structural systems is limited by the Seismic Design Category (SDC) of the building. SDC is a function of ground shaking potential and occupancy. All buildings in the same SDC are subject to the same general requirements. For example, the structural system of a hospital in Sacramento (Seismic Design Category D) will be designed to the same seismic requirements as a grocery store in San Diego (also Seismic Design Category D).

Therefore, regardless of which model code is chosen, significant amendments to the structural provisions of the code will be needed if the current level of safety in the 2001 *CBC* is to be maintained.

Reference Standards and Publications

Both *IBC* and *NFPA 5000* use referenced standards to cover some aspects of structural design and building construction, rather than include the text of the design requirements directly in the code. This is a departure from the 2001 *CBC*, where most of the requirements for design were contained directly in the code, and any amendments are clearly shown in the context of the code language. Many of the structural design provisions have been replaced, in whole or in part, by references to *ASCE 7-02, Minimum Design Loads for Buildings and Other Structures. IBC* relies on referenced standards for steel and concrete design, and some aspects of masonry design. In *NFPA 5000*, reliance on referenced publications is almost complete for all materials.

Numerous conflicts and inconsistencies exist in reference standards, which arise from a number causes, not the least of which is the fact that update and development cycles of the various referenced documents are not coordinated. The writers of the various standards attempt to coordinate their provisions with other standards, but this effort is not always successful. Additionally, referenced standards are routinely amended at the

national level, in the NEHRP *Provisions* and *ASCE 7*. These amendments correct many of the deficiencies in the referenced standards, but many others remain.

Resolving Conflicts Between Referenced Documents

In order for a building code to be easily usable and enforceable, the inconsistencies and conflicts between referenced standards must be resolved. To accomplish this, the model code organizations must have an efficient mechanism in place to resolve conflicts between referenced documents. If they are not resolved by the model code promulgating organization, then the adopting agency must use its resources to resolve conflicts. We asked questions of both model code organizations regarding the resolution of conflicts, with two objectives: first, to determine what mechanisms are used by the organization to deal with conflicting reference documents in the code development process and second, to determine how the apparent conflict can be resolved in the context of the code as written. The relationship between the code and the referenced documents, and the manner in which conflicts between referenced documents are resolved, appears to be fundamentally different in the *IBC* and *NFPA 5000*.

The seismic design provisions of *ASCE 7-02* provide an illustration of the differences between the two model codes, and the importance of this issue. *ASCE 7-02* refers to specific sections in specific editions of the materials standards for steel, concrete, and masonry design. Without these specific references, the seismic design provisions of *ASCE 7-02* are not readily usable. Different editions of the same standards are not interchangeable. A conflict exists when the model code makes reference to a specific edition of a material standard (for example, the 2002 edition of the masonry design standard), and *ASCE-7-02* refers to a different edition of the same referenced standard (for example, the 1999 edition of the masonry design standard).

In the *IBC*, secondary standards that are cited within a referenced standard are considered part of the code (Attachment B, Question 7). In addition, *IBC* materials chapters are relatively complete, and reference specific sections in reference standards, rather than the entire standard. This permits easier coordination between standards, since conflicting provisions are simply not included in the reference. For example, *ASCE 7-02,* Section A9.11, contains references to the masonry design standard *ACI 530-99*, which conflict with the provisions of *ACI 530-02*. However, *IBC* does not adopt *ASCE 7-02*, Section A9.11. Instead, *IBC* Chapter 21 contains a complete set of seismic design regulations for masonry that are coordinated with the appropriate portions of *ACI 530-02*.

In contrast, NFPA has given two different answers to the issue of secondary standards. The first states that in general, secondary and tertiary referenced documents are not considered part of the NFPA code. This renders *ASCE 7-02* unusable without substantial amendment, since the materials standards referenced therein, which are vital to the use of the document, are not valid references. Further, NFPA shifts the burden of sorting out the enforceability of secondary and tertiary references onto the

building official (Attachment A, response to Structural Question 6, page 17 of 22). NFPA, speaking of conflicts between the different editions of the masonry design codes, states "…as part of the review process, California will want to compare the seismic provisions of *ACI 530-99* with *ASCE 7-02*'s modifications to those of *ACI 530-02* to determine if there are conflicts and how best to deal with those conflicts." In the NFPA response to the OSHPD Preliminary Report, NFPA reverses this position, stating that secondary and tertiary references are enforceable. Even if this is the case, it does not resolve the issue raised in this example, since Section 43.2 of *NFPA 5000* refers specifically to *ACI 530-02*. *NFPA 5000* Section 1.3.2 states that where the requirements of a referenced code or standard differ from NFPA 5000, the requirements in NFPA 5000 shall govern. Therefore, it would be a violation of the NFPA code to substitute *ACI 530-99* (the edition referenced in *ASCE 7-02*) for *ACI 530-02*. As a result, of the 11 specific section references in *ASCE 7-02* to sections in *ACI 530-02*, 4 are correct, 2 refer to incorrect sections in *ACI 530-02*, and 5 refer to sections that do not exist.

If the writers of the standard or the model code promulgating organization do not resolve conflicts, then the adopting agency must use its resources to resolve conflicts. The process of identifying and then resolving these types of conflicts will require a significant staff effort and a large number of California amendments. The problem is acute with *NFPA 5000*, since that code relies almost entirely on referenced publications, many of which are not written in concise or enforceable language. While there are also potential conflicts in the *IBC*, ICC has taken a position on precedence that provides a framework to resolve conflicts.

In general, it is significantly more difficult to amend and use codes that make heavy use of referenced standards. The user must jump from standard to standard during the course of design or review. In addition, amended referenced standards can be difficult to use, because the code contains only the amendment, and the text of the referenced standard is generally not reproduced in the code. Hence, the user must first be aware that the standard has been amended, and then put the amendment into the proper context. The likelihood of errors is greatly increased. *NFPA 5000*, with its' complete reliance on referenced publications, will be more difficult to amend and use. The *IBC* will also be easier to use due to the fact that some of the text of the referenced standards is repeated in the model code.

Another difficulty arises from the fact that while *IBC* limits itself to the use of reference standards, *NFPA 5000* uses a broader group of documents, which are referred to as reference publications. The distinction is important. Referenced standards are likely to be written in concise, enforceable language. In contrast, the referenced publications in NFPA include a significant number of guidelines and manuals. Although *NFPA 5000,* Section 2.1 specifically states that these documents are part of the requirements of the code, the guidelines and manuals are typically written using language that is neither concise nor enforceable.

Amendment of Referenced Standards
Another fundamental difference between the ICC and NFPA deals with their approach to amending referenced standards during the model code development process. The *IBC* routinely amends referenced standards to eliminate conflicts or to meet performance objectives of the code (for example, see Chapters 19 and 21 of the 2003 *IBC*). While conflicts still exist in the *IBC*, there is a mechanism for resolving conflicts between referenced standards when they are identified in the code development process.

In contrast, NFPA technical committees may take one of several approaches in response to the conflict (Attachment A, Structural Questions 3b, page 15 of 22; Question 5, page 16 of 22): they may decide to accept the "differences" (i.e. accept conflicting provisions), they may adjust criteria in *NFPA 5000* not to conflict (i.e. amend *NFPA 5000*), or they may submit a proposed change to the referenced publication in its' next revision cycle (i.e. accept conflicting provisions, but attempt to get the "owners" of the referenced publications to resolve the difficulty). The first approach builds a conflict into the code. The second approach, (where the conflict is resolved in *NFPA 5000*) appears to have been rarely employed in the structural chapters. The third approach could take years to resolve, and even then the publisher of the referenced document may choose not to make the change. As noted above, this leaves the task of identifying and correcting conflicts in the referenced standards to California (Attachment A, response to Structural Question 6 sub-bullet, page 18 of 22).

Compared to the *IBC*, it will take significantly more effort to amend the structural provisions of the *NFPA 5000* code to eliminate apparent conflicts between the code and referenced standards and provide a level of safety equivalent to that found in the 2001 *CBC*.

Materials Standards
Both *NFPA 5000* and *IBC* reference documents that potentially conflict with the requirements of *ASCE 7-02*.

IBC
In the case of the *IBC*, this includes the 2002 editions of three standards: the masonry design standard, *ACI 530-02*; the concrete design standard *ACI 318-02;* and the steel design standard, *AISC 341-02*. *ASCE 7-02* references and amends the 1999 editions of all three standards. The conflicts will require coordination efforts on the part of the enforcing agency.

The coordination effort required for the concrete and steel chapters (Chapters 19 and 22) of the *IBC* appears manageable, since the technical changes in the standards were minor, and the new editions are organized such that cross referencing is still relatively straight forward.

Chapter 21 of the *IBC* contains extensive provisions for masonry, but also references *ACI 530-02*. There have been substantial technical changes between the 1999 and 2002 editions of *ACI 530* that must be reviewed. Our review of Chapter 21 indicates that, in general, the references between *ACI 530-02* and *IBC* have been coordinated. This will ease the technical correlation effort. In addition, since Section A9.11 of *ASCE 7-02*, which contains the specific references to *ACI 530-99,* is not adopted by *IBC*, the technical correlation effort can focus on only those sections of *ACI 530-02* referenced in Chapter 21 of the *IBC*.

Chapter 23 of the *IBC*, covering wood construction, is a comprehensive presentation of wood design. Compared to the 2001 *CBC*, the chapter is better organized, more concise, and very usable. *IBC* Chapter 23 contains requirements for both engineered and conventional construction.

NFPA 5000

NFPA 5000's handling of materials standards is less effective than that of the *IBC*. *NFPA* 5000 also references the 2002 editions of steel, concrete, and masonry standards. As with the *IBC*, the steel and concrete chapters, while potentially containing some conflicts, appear to be manageable.

The masonry design provisions present a far greater challenge. Aside from the *ACI 530-02*, there is little in the way of masonry requirements provided. Further, unlike the IBC, there was no apparent effort to coordinate section references between the structural design and masonry standards, nor is it simply a matter of updating the references in *ASCE 7-02* to the correct portions of *ACI 530-02*. Weaknesses in *ACI 530-02* have been identified in 2003 *NEHRP Provisions* update process, that must be considered.

The wood design chapter in *NFPA 5000* (Chapter 45) appears to be unenforceable as written. Chapter 45 contains references to material and design standards, and durability provisions. In the 2001 CBC, wood frame construction is designed using the Allowable Stress Design method. The corresponding provisions in *NFPA 5000* consist of a reference to the American Forest Products and Paper Association (AF&PA) *Allowable Stress Design (ASD) Manual for Engineered Wood Construction*.

The *ASD* manual referenced in *NFPA 5000* actually consists of six documents: the manual itself; the 2001 *National Design Specification (NDS)* for wood and a supplement volume to the *NDS*; a supplement volume covering lumber, glu-lam beams, poles, shear walls, and diaphragms; a supplement volume titled *Special Design Provisions for Wind and Seismic*; and a volume of guidelines covering I-joists, composites, trusses, and metal connectors.

The ASD manual, which is the primary referenced document, is an excellent resource for designers, but it is not an enforceable code document. Of the six volumes that make up the ASD manual only two, the 2001 *NDS* and *NDS Supplement* are written in an

enforceable style. The manual contains examples, “featured projects” such as a fast food restaurant, a warehouse, a reservoir cover, etc., and is more in the form of a textbook and guide than a building code. The volume on special design for wind and seismic is written in a somewhat enforceable style, but the requirements are not incorporated into the manual (the primary referenced document) in an enforceable manner. It also contains material that duplicates and in some cases conflicts with the requirements in other volumes. No order of precedence is established amongst the various volumes.

For conventional construction provisions, *NFPA 5000* references the AF&PA *Wood Frame Construction Manual for One and Two Family Dwellings*, 2001 edition. Although it is an ANSI accredited standard, this two-volume set is also a mixture of enforceable and unenforceable language. The actual conventional construction requirements are scattered throughout the text, interspersed with narrative, design aids, etc. Further, the standard is narrowly scoped to apply only to one and two-family dwellings, and would therefore be inappropriate for use on hospital, licensed clinic, or skilled nursing facilities projects. Nothing in *NFPA 5000* or its referenced documents covers conventional construction requirements for wood buildings under OSHPD’s jurisdiction.

There are other referenced publications in the wood chapter that do not appear to be enforceable, such as the AF&PA *Load and Resistance Factor Design (LRFD) Manual for Engineered Wood Construction* and the Southern Pine Council *Wood Foundations Design & Construction Guide.*

In general, the problems with the *NFPA 5000*, Chapter 45, “Wood,” are systemic, and severe. If adopted, OSHPD would be forced to create an entirely new wood chapter from scratch, built around the 2001 NDS and NDS Supplement.

Tests and Inspections

NFPA 5000 and *IBC* handle structural tests and Inspections in different manners. Chapter 40 of *NFPA 5000* grants the Registered Design Professional broad powers in determining the scope and frequency of tests and inspections. Narrative outlining tests and inspections for different types of construction is given, but references to the appropriate sections of the code or referenced standards are not provided, and the charging language is somewhat vague. Section 1.7.6.6.3 establishes mandatory inspections. However, structural special inspections are not explicitly referenced in Section 1.7.6.6.3.1(N), although there is a reference to Section A.9.3 of *ASCE 7-02*, which does cover some special inspections.

In contrast, *IBC* Chapter 17, “Structural Tests and Inspections,” emphasizes special inspections and required inspections are listed in tables, which also provide references to the appropriate sections of the code or referenced standards.

OSHPD adopts *CBC* Appendix Chapter 33 on site grading. *IBC* contains corresponding provisions in Appendix J. There are no corresponding provisions in *NFPA 5000*.

GENERAL CODE PROVISIONS

Code Format

Although the technical content of the *IBC* is different from the *CBC* in many areas, the format of the *IBC* is similar to the *CBC*. This will make it easier to move existing California amendments to the *IBC* and find appropriate places for new amendments. The format of *NFPA 5000* is very different from the current *CBC*, which will make the task of amending it more difficult, though not insurmountable.

Use of Exceptions within *NFPA 5000*

Another difference with the NFPA format that will increase the difficulty of writing amendments (and increase the confusion of using the code) is NFPA's policy regarding exceptions. The NFPA *Manual of Style* does not permit exceptions when it is possible to word the text as requirements. This sometimes results in confusing or contradictory code requirements. For example, *NFPA 5000* Section 19.1.1.4.1.2 states that "doors…shall normally be kept closed," and Section 19.1.1.4.1.3 states, "doors…shall be permitted to be held open if they meet the requirements of 19.2.2.2.7." On face value, the two sections seem to contradict each other, but the second is really an exception to the first.

In spite of their written policy severely limiting the use of exceptions, the *NFPA 5000* makes liberal use of exceptions in some chapters (See *NFPA 5000*, Chapter 15 Building Rehabilitation – 124 exceptions in 19 pages – and Chapter 16 Assembly Occupancies – 87 exceptions in 16 pages).

In response to our question regarding the policy on exceptions, (see Attachment A, page 9 of 22, question 10), NFPA stated, "NFPA staff has never encountered code text that cannot be effectively expressed in the form of requirements without the use of exceptions. There should never be a case where the 'exception' format is needed. Rather, there is a big need for careful code wording so as to avoid apparent conflicts."

References Within the Model Code

NFPA 5000 also tends to use extremely broad section references in the structural chapters. For example, in Chapter 36, "Soils, Foundations, and Retaining Walls," Section 36.1.1 requires that structures in Seismic Design Categories C through F comply with the requirements of *ASCE 7-02* Sections 9 and A9.7. These two sections encompass over 100 pages, and the NFPA code section forces the designer and plan reviewer to laboriously search through this volume of material, looking for requirements that might apply to soils, foundations, and retaining walls. In contrast, *IBC* refers to specific sections throughout Chapter 18, "Soils and Foundations," allowing both the designer and plan reviewer to focus on the appropriate regulations.

Another example is illustrated by the case of steel piles. *NFPA 5000*, Section 36.5.7 requires that steel piles conform to the requirements of Chapter 44, which in turn never mentions piles. It does reference a number of documents that both the designer and

plan reviewer will have to search, looking for provisions applicable to piling. The *IBC* tends to provide much more precise and complete references to specific code sections. For example, *IBC* Section 1809.3 references the specific requirements for piles, including materials, allowable stresses, and dimensions.

Architectural Amendments
Since both the model codes seem to provide roughly equivalent levels of protection (with some exceptions), we believe they will require a comparable number of amendments to bring either code to the level of the current *CBC*. However, as noted above, the organization and style of *NFPA 5000* will make the amendment process more difficult.

A significant investment of resources will be required to update various OSHPD documents (PINs, CANs, FREER Manual, reference materials) to coordinate with either new code. The *IBC* will require less time for this process, again because of the unfamiliar format of *NFPA 5000*.

Performance-Based Design
NFPA 5000 includes provisions for performance-based design, which allows more flexibility for designers, but greatly increases the amount of work needed to design, review and approve projects utilizing this method. The performance-based design requirements contain requirements that appear vague and unenforceable. For example, the criteria at the serviceability performance level include a structural requirement that “Structures shall not experience permanent deformation or deflection or deformation or deflection that is troubling to occupants or disruptive of building function.” How would the phrase “troubling to occupants” be enforced? ICC has placed its requirements for performance-based design in a separate code document, which appears to be a much better approach.

OTHER CONSIDERATIONS
Training
The amount of training that will be necessary with the adoption of either model code was also considered. There are substantial technical changes in both codes, requiring a significant amount of training to become familiar with these new provisions. From a structural perspective, both designers and building officials will require extensive training on all the referenced standards.

The IBC is organized along the same general lines as the 2001 *CBC*, so the format will be familiar to most users. *NFPA 5000* follows an entirely different format, and additional training will be required to become familiar with this new format. In addition, because of the need for OSHPD to make significant amendments to resolve conflicting provisions, *NFPA 5000* will require more extensive training to understand and properly apply.

"California Code"

The use of a code in California that is different from the one used in the other states is an issue that can significantly impact the cost of doing business in the state. Many owners and designers of health care facilities conduct business in more than one state. Using a building code in California that is radically different from the rest of the nation will impose a tremendous burden on building owners and their consultants. As of June 4, 2003, the *IBC* has been adopted by 26 states, and in various jurisdictions in 43 states. *NFPA 5000* has been adopted in only one city in the nation. If California adopts *NFPA 5000*, it will make the task of architects, engineers and hospitals that do business in California and other states much more difficult and costly.

Insufficient Development

Many building industry professionals feel the *NFPA 5000* code is not yet ready for widespread use. It is a brand new code, presented in a format that has not been used for a modern building code. It incorporates new concepts in building design, and has never been "tested" to demonstrate the effectiveness or usability of these new ideas.

An example that demonstrates how new some of the concepts in *NFPA 5000* are relates to allowable heights and areas of buildings. One of OSHPD's questions to both code organizations requested justification for the increased allowable heights and areas of buildings in both the *IBC* and *NFPA 5000*. In their response, NFPA states that the task group dealing with height and area requirements "set out to develop a new approach, grounded in scientific principles" rather than the "traditional height and area requirements…based primarily upon experience." At one point in the process, the task group "concluded there were still several unresolved issues surrounding this new approach…and it was simply not ready to be included in *NFPA 5000*." Instead, they substituted "heights and areas that are familiar to architects, engineers and code officials," that is, heights and areas virtually identical to those found in the *IBC*.

Support Services

With regard to support services (interpretations, evaluations, training), both organizations have promised to offer roughly equivalent support services. However, ICC has all of their support services in place already, and they are familiar to designers, contractors, and building officials, through their experiences with ICBO. NFPA has promised to provide the same services, but many of them are not yet in place, or are in their infancy. Therefore, there is insufficient data available to be able to evaluate the NFPA support services. In addition, while NFPA has extensive experience supporting the standards, they have no experience providing support for a building code.

Code Development Process

There has been much debate about the influence of the model code development process on the quality of the final code document. ICC has been developed through a "governmental consensus" process that is familiar to users of the *UBC*. In this process, all changes to the code are approved by building officials. *NFPA 5000* is developed using their ANSI accredited consensus process, whereby proposed changes are

reviewed by Technical Committees composed of industry representatives, government enforcers, consumers, business persons and others. Proposed changes are then submitted to a vote of the NFPA membership at the annual meeting. Both methods can produce useful and effective documents, but NFPA's reliance on the ANSI process severely limits their ability to effectively coordinate the host of referenced publications contained in the *NFPA 5000* code, since amendment of one ANSI document by another ANSI document is strongly discouraged.

OSHPD believes that either process is capable of producing an acceptable code document, but the proof of the process is in the product. Rather than prolong the debate over which process is "better," we focused our evaluation on the merits of the actual code document.

Code Organizations

While the ICC is a new organization, combining the ICBO, BOCA and SBCCI code organizations, it is in many ways familiar to those who have worked in the ICBO process. The support services and technical expertise of these three organizations has been merged into the ICC. The *IBC* is a compilation of the three organizations' model building codes. Many decades of code development have been incorporated into the *IBC*, and it has been used throughout the country in the 2000 edition.

NFPA has a long history of standards development. Their documents are used as the industry standard for many types of fire protection systems. *NFPA 5000* is a new building code. Although based largely on *NFPA 101 Life Safety Code*, it has never been used in practice for the design or construction of buildings.

CONCLUSION

Clearly, the task of evaluating these documents for consideration as the basis for the next California Building Standards Code is a monumental task. No one criterion can be ranked above another; fire and life safety, structural, architectural and other portions are equally important. Our evaluation has shown that the fire and life safety and architectural portions of the codes are nearly equivalent, with neither code presenting a clear reason to select one over the other.

The structural issues are quite a different matter. Here, the *IBC* is clearly superior in technical content, completeness, coordination, and presentation. In a number of areas, including, tests and inspections, foundation design, and wood design, the *IBC* is superior to the *CBC,* and vastly superior to *NFPA 5000.*

Both model codes will require amendments to maintain current height, area, and fire sprinkler requirements, and will require amendments to prevent the reintroduction of non-ductile structural systems into California. In the case of *NFPA 5000*, conflicts and omissions exist in the structural provisions that make the document extremely difficult to use in its current form. If adopted, these conflicts will have to be resolved at both the state and local levels. Unfortunately, local jurisdictions can only amend the code for

specific climactic, geographic and topographic reasons, and the state agencies have limited authority for only their statutory jurisdiction. This will leave the local jurisdictions with a building code that contains known conflicts and unenforceable language. Local amendments cannot be adopted at the state level. Therefore, design requirements will vary considerably throughout local jurisdictions statewide.

Based on our analysis, the following codes represent the best choice for buildings under OSHPD jurisdiction, and, in our opinion, for the State of California.

- The *International Building Code*, published by ICC
- The *International Residential Code*, published by ICC*
- The *International Fire Code*, published by ICC
- The *National Electrical Code*, published by NFPA
- The *Uniform Plumbing Code*, published by IAPMO
- The *Uniform Mechanical Code*, published by IAPMO

  * The IRC would not be adopted by OSHPD, but would be useful to jurisdictions regulating residential occupancies in the state.

The following items represent a summary of our reasons for this selection.

- The *IBC* will require much less work to amend. While *NFPA 5000* could be amended to be workable, we estimate it will require double the effort on the part of OSHPD, compared to adoption of the *IBC*.

- The *IBC* is a familiar format, and will be readily accepted by design professionals and building officials. The task of retraining for a new code will be minimized.

- Health and Safety Code Section 18930 (a)(9) (the 9-point criteria) requires that the State Fire Marshal (SFM) review all regulations proposed by State Agencies to determine if the regulation promotes fire or panic safety. Selection of *NFPA 5000*, with its need for extensive amendments, will generate a significant increase in workload at the SFM. This will almost certainly delay SFM's response to the state agencies, which will in turn delay the code adoption cycle.

- Given the limitations imposed by the current fiscal environment in state government, OSHPD is not able to quickly and efficiently handle the volume of work that adopting *NFPA 5000* would create.

- Selection of *NFPA 5000* will result in delays in design and review of projects, as people struggle to become familiar with an entirely different code format. These delays will be costly to the healthcare industry, and will impact the delivery of healthcare services to the people of California.

- The IBC provides a better structure in which to use referenced standards, and allows referenced standards to be amended within the model code to eliminate conflicts.

- The mixture of enforceable and unenforceable language found in portions of the structural provisions of *NFPA 5000*, rather than providing design flexibility, will cause confusion and delays to designers and enforcers, as they struggle to determine exactly what the code requires.

- Because the wood chapter in *NFPA 5000* is unenforceable as written, an entire group of structures under OSHPD jurisdiction (single story Skilled Nursing Facilities and many licensed clinics) cannot be constructed using *NFPA 5000* as written. This will require writing an entirely new chapter for wood design.

- If California adopts *NFPA 5000*, California's design and construction communities will be placed at a severe economic disadvantage when pursuing work outside California. Also, many designers, contractors and building owners in other states may be reluctant to initiate work within California, since working with a totally different building code from the rest of the nation would create economic and logistic difficulties.

- Both *NFPA 5000* and *IBC* will require amendments to maintain a level of safety comparable to that found in the *CBC.* In the case of the structural provisions, the changes needed in the *IBC* are narrow in focus, and chiefly arise from technical changes in the national standards. In contrast, the amendments required to bring *NFPA 5000* to a workable level are broad, arising from systemic issues in scope and format, as well as technical problems. This is most clearly illustrated by the problems with the wood chapter, which is completely unenforceable. Given enough time, the state agencies can address these issues, however, local jurisdictions will be faced with a nearly impossible task as they attempt to enforce these requirements.

- Adopting the *IBC* will fulfill the stated intentions of both ICC and NFPA, in having a single building code that is applicable throughout the United States. This will greatly reduce the burden and frustration of interstate design and construction.

- Finally, and most importantly, the IBC will provide greater clarity, ease of use, and quality, and will therefore result in the highest level of safety for the people of California.